

### **REMARKS**

Claims 1-4, 6, and 8-11 are pending in the application, with claims 1-4, 6, and 8 being currently amended, claims 5 and 7 being newly cancelled, and claim 11 being newly added. Applicants note that previously pending dependent claim 2 has been amended to an independent claim. Also, an advantage of the invention, as it pertains to the electrical action, is that the forward voltage can be restricted when voltage is applied in the forward direction, and excellent voltage resistance characteristics can be ensured when voltage is applied in the reverse direction, as described in the paragraphs [0039], [0040] and [0041]. In view thereof, claim 11 has been newly added.

With respect to the Official Action, Applicants acknowledge Examiner's remark concerning the lack of support in Japanese Patent Application No. 2004-289248 for the claim of foreign priority for the embodiment found in Fig. 8 of Applicants' disclosure. *See* Official Action, paragraph 1.

Also in the Official Action, Examiner objects to Fig. 9 as needing to be designated by the legend "Prior Art". *See* Official Action, paragraph 2. In view thereof, Applicants submit herewith a replacement drawing sheet showing Figs. 8 and 9, with Fig. 9 now designated by the "Prior Art" legend. Thus, the objection is overcome. In addition, on that same replacement drawing sheet, in Fig. 8, the phrase "forward voltage" has been corrected to recite "forward current". Applicants also submit herewith a replacement drawing sheet showing Figs. 1 and 2, with Fig. 1 similarly including the phrase "forward current" in place of "forward voltage". Notably, the Japanese to English translation resulting in the phrase "forward voltage" was incorrect. Instead, the proper phrase should have been "forward current". Support for the

replacement of "forward voltage" with "forward current" in Figs. 1 and 8 can be found throughout the specification and at least at paragraph [0039] and [0042], for example.

In addition, Examiner has also objected to the title of the invention because it allegedly is not descriptive and, in turn, suggests the following title: "III-V Nitride Semiconductor Device Comprising A Concave Schottky Contact And A Concave Ohmic Contact". *See* Official Action, paragraph 3. Applicants are grateful for Examiner's assistance with a new title and have elected to substantially adopt the same. To that end, "Semiconductor Device" has been changed to "III-V Nitride Semiconductor Device Comprising A Concave Schottky Contact And An Ohmic Contact". In view thereof, Applicants submit that the objection to the title is overcome.

**35 U.S.C. §112, 2<sup>nd</sup> Paragraph -- Rejection of Claims 1-10**

In the Official action, claims 1-10 stand rejected under 35 U.S.C. §112, second paragraph, as being indefinite. *See* Official Action, paragraph 4.

In view of the rejections, independent claims 1-3, as well as dependent claims 4, 6, and 8, have been amended to more clearly define Applicants' invention, as further discussed next.

Concerning previously pending claim 1, Examiner states that it is not clear from the disclosure how the concave portion faces the interface, what surface faces the interface, or how the concave portion may face the interface even as it extends deeper than said interface.

To that end, claim 1 has been amended to more clearly recite a semiconductor device that includes, in part, a first concave portion that is formed penetrating at least the second semiconductor layer from a primary surface of the second semiconductor layer that faces the interface between the first semiconductor layer and the second semiconductor layer, and is formed from the interface to a predetermined depth in the first semiconductor layer. In addition, the

claim now recites that a first electrode is formed on a bottom surface and side surface of the first concave portion and that forms a Schottky junction to the semiconductor layers which contact the bottom surface and the side surface of the first concave portion. Support for the amendments can be found throughout the specification and at least at paragraphs [0034], and original claim 2, for example. Applicants submit that claim 1 is no longer indefinite.

Concerning claim 2, Examiner states that it is not clear how the first electrode faces the two-dimensional carrier or how the first electrode may face the two-dimensional carrier even as it extends deeper than said two-dimensional carrier.

To that end, claim 2 has been amended to more clearly recite a semiconductor device that includes, in part, a first concave portion that is formed from a primary surface of the second semiconductor layer that faces the interface between the first semiconductor layer and the second semiconductor layer reaching at least the interface, and is formed to a distance that allows a quantum mechanical tunnel effect with the two dimensional carrier to be obtained. In addition, the claim further recites a first electrode that is formed on a bottom surface and a side surface of the first concave portion and that forms a Schottky junction to the semiconductor layers which contact the bottom surface and side surface of the first concave portion. Support for the amendments can be found throughout the specification and at least at paragraph [0035], Fig. 5, and original claim 1, for example. Applicants submit that claim 2 is no longer indefinite.

Concerning claim 3, Examiner, as with claim 1, similarly states that it is not clear how the concave portion faces the interface, what surface faces the interface, or how the concave portion may face the interface even as it extends deeper than said interface.

To that end, claim 3 has been amended to more clearly recite a semiconductor

device that includes, in part, a second semiconductor layer that is formed from a second semiconductor material above the first semiconductor layer, and a first concave portion that is formed penetrating at least the second semiconductor layer from a primary surface of the second semiconductor layer that faces the interface between the third semiconductor layer and the second semiconductor layer, and is formed from the interface to a predetermined depth in the first semiconductor layer. In addition, the claim further recites a first electrode that is formed on a bottom surface and side surface of the first concave portion and that forms a Schottky junction with the semiconductor layers which contact the bottom surface and the side surface of the first concave portion. Support for the amendments can be found throughout the specification and at least at paragraph [0034] and Fig. 8, for example. Applicants submit that claim 3 is no longer indefinite

Finally, dependent claims 4, 6, and 8 have been further amended to depend properly from currently amended claims 1-3 and to overcome the remaining §112 issues as set forth in the Official Action at paragraph 4.

In view of the foregoing amendments, Applicants respectfully submit that the §112 rejections have been overcome and must be withdrawn.

### **35 U.S.C. §102 -- Rejections of Claims 1, 2, and 10**

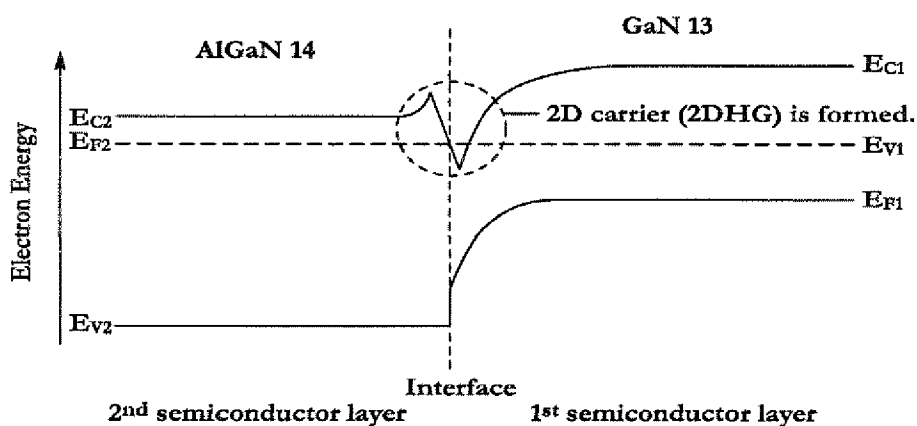
In the Official Action, claims 1, 2, and 10 stand rejected under 35 U.S.C. §102(b) as being anticipated by Margalit U.S. Patent No. 4,636,823 ("Margalit"). *See* Official Action, paragraph 5.

It is well established that "a claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art

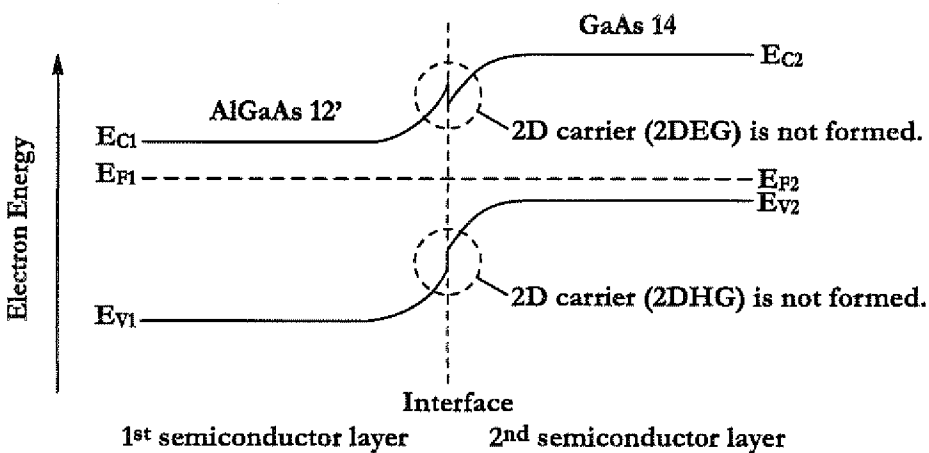
reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). For the following reasons, Margalit clearly fails to teach each and every element of Applicants' semi-conductor device as recited in independent claims 1 and 2.

In the Official Action, Examiner states that a two-dimensional carrier is formed within the first semiconductor layer and in the vicinity of an interface between the first semiconductor layer and the second semiconductor layer (col. 5, lines 21-45 of Margalit). *See* Official Action, paragraph 5. However, no description of a two-dimensional carrier is disclosed in the relevant parts cited by Examiner, or anywhere in Margalit. Indeed, because AlGaAs<sub>12'</sub> has a wider band and a higher Fermi level as compared with GaAs<sub>14</sub>, no two-dimensional carrier could be formed. Thus, Margalit clearly fails to have any two-dimensional carrier, which has a low-resistance current path in the vicinity of the heterojunction, as described in the present application and required by independent claims 1 and 2. Therefore, the effect of the present application cannot be achieved in that the forward voltage can be restricted when voltage is applied from the first electrode to the second electrode in the forward direction. As a reference, the energy band diagrams of the present application and Margalit are described as follows:

(The present application)



(Margalit)



In general as described in U.S. Patent No. 5,105,241, a two-dimensional electron gas (2DEG) layer can be formed when a N-AlGaAs semiconductor is formed on a non-doped InGaAs semiconductor. Since the InGaAs semiconductor is non-doped, the movement of the electrons in the 2DEG layer cannot be obstructed by the dopant in the InGaAs semiconductor which determines the type of the electroconductivity.

For all of the above reasons, Margalit does not teach (or suggest) Applicants' independent claims 1 and 2, or any of their dependent claims.

**35 U.S.C. §103 -- Rejections of Claims 1-5 and 8-10**

In the Official Action, Claims 1-5 and 8-10 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Fukuzawa U.S. Patent No. 4,772,925 ("Fukuzawa") in view of Margalit. *See* Official Action, paragraph 6.

A *prima facie* showing of obviousness is satisfied if there is an apparent reason to combine the prior art references flowing from either the references, the knowledge of one of ordinary skill in the art, or from the nature of the problem to be solved, and the results are expected. *KSR Int'l. Co. v. Teleflex Inc.*, 127 S.Ct. 1727, 1740 (2007); *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). In addition, to establish *prima facie* obviousness of a claimed invention, it is certainly well established that all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). In the instant case, Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness for the reasons that follow. Thus, the rejection of claims 1-5 and 8-10 should be withdrawn.

Margalit has been discussed above. Those same arguments apply equally with respect to this rejection.

Further concerning Fukuzawa, in FIG. 3A, a concave portion in which a gate electrode 6 (which corresponds to a first electrode in the present application) forms a Schottky junction is formed only on the inside of the third semiconductor layer 4 (which corresponds to a second semiconductor layer in the present application) between the second semiconductor layer 3 and the third semiconductor layer 4 or a deeper position. In addition, since the invention of

Fukuzawa is FET, it is designed so that the electric current between the gate electrode 6 and the source electrode 5 is restricted. Accordingly, when the constitution of the present application, which decreases the forward voltage, applies to the gate electrode of FET in Fukuzawa, it cannot achieve the effect that the ON resistance between a Schottky electrode and an Ohmic electrode can be decreased when the forward voltage is applied, as described in the present application and required by independent claims 1-3.

In view of all of the above, the combination of Fukuzawa and Margalit does not render obvious Applicants' independent claims 1-3, or any of their dependent claims.

Finally, dependent claims 6 and 7 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Fukuzawa in view of Margalit, and further in view of Patel U.K. Patent Application Publication No. 2 279 806. Claim 7 has been canceled, however, pending claim 6 depends from independent claims 1 or 3. Therefore, Applicant submits that the Examiner's rejection of claim 6 is in error for at least the same reasons discussed above with respect to claims 1-3. Moreover, an Ohmic electrode is formed in a concave portion in Patel, but it fails to form a Schottky electrode in a concave portion. As described in paragraph [0047], a Schottky electrode is formed in a concave portion, and not an Ohmic electrode in the present application, and thereby it can be achieved not only in that the ON resistance can be decreased when the forward voltage is loaded but also in that the parasitic capacitance which is generated between the first electrode 15 and the two-dimensional carrier 102 can be decreased and the high frequency characteristics can be improved when the reverse voltage is loaded. This is an effect that cannot be achieved when the Ohmic electrode is formed in a concave portion in Patel.



### **No Prima Facie Case**

For all of the above reasons, it is submitted that the claims as pending are patentable over the cited references, and that no prima facie case of obviousness was made before, nor would be applicable here over that same art. In that regard, the additional art cited by Examiner as being of interest is submitted not to change the situation.

### **Conclusion**

As a result of the remarks given herein, Applicants submit that the rejections of the pending claims have been overcome. Therefore, Applicants respectfully submit that this case is in condition for allowance and requests allowance of the pending claims.

If Examiner believes any detailed language of the claims requires further discussion, Examiner is respectfully asked to telephone the undersigned attorney so that the matter may be promptly resolved. Applicants also have submitted all fees believed to be necessary herewith. Should any additional fees or surcharges be deemed necessary, Examiner has authorization to charge fees or credit any overpayment to Deposit Account No. 23-3000.

Respectfully submitted,  
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